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ABSTRACT

One of a set of fourteen instructional outlines for use in a course to train novice firemen, this guide covers the topic of protective breathing equipment. The various types of breathing equipment and their use are described as well as the major respiratory hazards such as smoke and gases. This outline is to be used in conjunction with the International Fire Service Training Association's manual, "Fire Service Rescue and Protective Breathing Practices" (see note). (An outline of the whole course covering all fourteen topics briefly is provided in the first volume of the set--CE 016 662.) (ELG)

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PROTECTIVE BREATHING EQUIPMENT

PURPOSE

One of the fundamental rules in firefighting should be that no one, unless equipped with protective breathing equipment, be allowed to enter a building heavily charged with smoke and gas. Many fire departments have not been taking full advantage of modern protective breathing equipment. This is evidenced too frequently by men, who overcome by smoke or other gases, stagger out or have to be carried out of contaminated areas.

Due to new processes and materials, firefighters are coming in contact with many gases not formerly encountered. When firefighters enter such areas without the proper respiratory protection, it indicates that they have not been properly informed by those who are charged with that responsibility.

A knowledge of the operation of protective breathing equipment and a recommended method of wearing it will increase the efficiency of fire department operations.

This outline was developed to be used in conjunction with the International Fire Service Training Association Manual, Fire Service Rescue and Protective Breathing Practices.

AIM

To present approved information and techniques for the use and handling of protective breathing equipment.

COURSE OUTLINE	GUIDES

I. Purpose of Breathing Equipment.

A. Aids rescue in areas.

1. Filled with smoke and noxious gases.

2. That have an oxygen deficiency.

B. Aids in firefighting.

1. Speeds attack - rapid entry.

2. Enables firefighters to locate fire.

C. CAUTION - Breathing equipment offers no protection against fire, heat, or skin irritants.

1. When it gets too hot to stay in a building without breathing equipment, it is too hot to remain in the building.

2. Breathing equipment does not protect against gases that attack the skin, such as hydrocyanic acid.

II. Types of Breathing Equipment.

A. Self-contained equipment.

1. Oxygen-generating.

2. Demand regulator.

(a) Air.

(b) Oxygen.

3. Oxygen-rebreathing.

COURSE OUTLINE	GUIDES
B. Filter (See Section V, Item D).	
C. Supplied air type.	
III. Respiratory Tract.	
A. Purpose is to supply oxygen to the blood stream.	Rescue & Protective Breathing Prac., p. 9, Fig. 1
B. Main elements.	
1. Nose.	
2. Mouth.	
3. Trachea (windpipe).	
4. Lungs.	
C. Man requires approximately 16% oxygen to remain conscious.	
1. Normally air contains 20.92% oxygen.	
2. 16% oxygen is also required for a free burning fire.	
3. If open flame does not exist, man cannot live.	
IV. Respiratory Hazards to Fire Fighters and Rescue Workers.	
A. Smoke.	
1. Contents.	
(a) Oxygen.	
(b) Nitrogen.	
(c) Carbon dioxide.	

COURSE OUTLINE	GUIDES
(d) Carbon monoxide. (e) Finely divided particles of soot and carbon. (f) Many products from the combustion of wood and other materials. 2. Normally not extremely dangerous but will cause discomfort when inhaled. 3. Most smoke particles and elements can be removed by filtering <u>but</u> many dangerous gases found with smoke <u>cannot</u>. B. Acid gases. 1. Types. (a) Chlorine. (b) Hydrogen sulfide. (c) Phosgene. 2. These gases can be controlled only by neutralizing them with products such as caustic soda. C. Anesthetic gases and vapors. 1. Group I - causes anesthesia but does not cause serious after-effects when exposure is long and concentration is low. (a) Acetylene. (b) Gasoline. (c) L. P. Gas.	

COURSE OUTLINE	GUIDES

2. Group II - injures the liver, kidneys, brain, nervous system, and other organs after long exposure.

   (a) Methyl chloride.

   (b) Carbon tetrachloride.

   (c) Carbon disulfide.

D. Irritant gases.

1. Group I - affect upper respiratory tract, highly soluble in water, such as ammonia.

2. Group II - affect middle and upper respiratory tract.

   (a) Chlorine.

   (b) Sulfur dioxide.

3. Group III - primarily affect lungs causing them to fill with water.

   (a) Phosgene.

   (b) Nitrous oxide.

E. Asphyxiant gases.

1. Group I - simple asphysiants -- act mechanically by excluding oxygen.

   (a) Carbon dioxide.

   (b) Methane.

   (c) Hydrogen.

COURSE OUTLINE	GUIDES
2. Group II - chemical asphyxiants - combine with red blood cells or tissues and prevent oxygen from being utilized.	
(a) Carbon monoxide.	
(b) Hydrogen cyanide.	
V. Using Protective Breathing Equipment.	
A. Facepieces.	
1. Almost all self-contained breathing equipment supplies the wearer with air or oxygen through a flexible tube attached to a facepiece.	
2. Facepieces fit the curvature of the face and are held in place by a head harness.	
3. Donning the facepiece.	Rescue & Protective Breathing Prac., p. 26, 27, Fig. 2
(a) Loosen straps, fold them across the top of the facepiece, and grasp mask at upper sides with both hands.	
(b) Place chin into pocket at bottom and fit facepiece to forehead and temples.	
(c) Remove hands from facepiece, but hold the harness and pull it over the top of the head.	
(d) Tighten chin straps first by pulling out and back on tabs. (Bottom strap should be across back of neck and below ears, and harness should be on back of head, not on top).	
(e) Tighten temple straps.	
(f) Tighten top straps.	

COURSE OUTLINE	GUIDES
4. Testing the facepiece. (a) Hold one hand over end of breathing tube. (b) If facepiece fits snugly, it should collapse against the face. B. Self-contained demand regulator breathing equipment. 1. The demand regulator type provides eye and respiratory protection and is limited to the amount of air and/or oxygen carried in the supply cylinder. 2. Parts. (a) Air or oxygen cylinder. (b) Cylinder valve - controls the supply of air or oxygen from cylinder to the regulator shutoff valve. (c) Regulator hose. (1) Connects the cylinder to the regulator. (2) Ruggedly built of metal reinforced neophrene. (d) Regulator. (1) A reducing valve. (2) It lowers the air under pressure; thus the air reaches the facepiece at low pressure as the breathing of the wearer demands it.	Rescue & Protective Breathing Prac., p. 28, 29, Fig. 3, 4, 5

COURSE OUTLINE	GUIDES
(e) Regulator shutoff valve. (1) Yellow or green knob opposite bypass valve where regulator and regulator hose connect. (2) Provided to sut off the regulator in event of failure. (3) Should always be fully open and locked open. (4) Close it only after emergency bypass valve has been opened. (f) Emergency bypass valve. (1) Red knob opposite the regulator shutoff valve. (2) Provided to give a continuous flow of air to the facepiece, bypassing the regulator shutoff valve. (3) Use when regulator valve is closed or fails to function. (4) Adjust bypass valve to allow flow of air to suit user's requirements. (g) Facepiece and corrugated hose. (1) Rubber face mask with non-fogging laminated safety glass lens and attached corrugated rubber hose. (2) Provides air to the wearer. (3) M.S.A. and Scott supply a speaking diaphragm.	

COURSE OUTLINE	GUIDES
(h) Exhalation valve. (1) Diaphragm valve located on the facepiece through which exhaled air passes to the outside atmosphere. (2) Also permits conversation at short range. (i) Safety chain or lever. (1) Attached to cylinder valve assembly. (2) Snap-on chain or lever fastens into cylinder valve handwheel to keep valve from being turned off accidentally. (j) Regulator pressure gauge. (1) Attached to regulator in plain view of wearer of mask. (2) Shows exact pressure in air cylinder. (3) Another gauge (cylinder pressure gauge) is located on the cylinder valve assembly and serves the same purpose. (k) Quick-connect coupling. (1) Attached to corrugated breathing tube for easy immediate connection to regulator. (2) A good connection is assured when tightened with fingers.	

COURSE OUTLINE	GUIDES
3. Procedures for conning self-contained demand regulator breathing equipment. (a) Most demand regulator equipment is similar in general design and operation. However, the style and location of some parts is often different. (b) Because of this difference in style and parts location, and because demand regulator equipment comes in different sizes, which in turn determines the method of donning, no one method of donning this equipment will be given. The International Fire Service Training Manual, Fire Service Rescue and Protective Breathing Practices, describes the different methods of donning one manufacturer's equipment. This can be used as a reference guide.	Rescue & Protective Breathing Prac., p. 31-34 Fig. 6; p. 35-38 Fig. 7; p. 39-41 Fig. 8; p. 43-45 Fig. 9
4. Inspection, testing, and care of self-contained demand breathing equipment. (a) Major causes of defective equipment. (1) Uncleanliness. (2) Deterioration. (3) Loss of pressure. (b) Weekly visual check. (1) Condition of carrying device. (2) Condition and completeness of unit. (3) Proper cylinder pressure.	

COURSE OUTLINE	GUIDES
(c) Quarterly inspection and test. (1) Remove equipment from service. (2) Perform complete test of the following: a. Valves. b. Pressure regulators. c. Gauges. d. Harness. e. Facepiece. (d) Two and a half year test by factory or factory representative. (1) Regulator hose. (2) Regulator. (e) Five year test. (1) Hydrostatic test of cylinder. (2) The above test must be conducted and recorded on cylinder to meet U. S. Department of Transportation requirements. (f) General maintenance and testing. (1) When dirty, wash entire unit in warm, soapy water. (2) Check for leaks with soapy water or children's "bubble solutions."	

COURSE OUTLINE	GUIDES
(3) Be sure all connections are tight. (4) Protect from sun, dust, hot air, and steam. (5) Do not subject cylinder to sudden pressure increases. (6) Be especially careful of demand regulator. (g) Precautions to be observed with demand regulator. (1) Do not use oil or grease on this breathing equipment. (2) If automatic demand valve becomes inoperative, open bypass valve (red) to escape to fresh air. Close shutoff valve (yellow or green). (3) Should diaphragm and housing be blown off, use hand as housing, operate red valve, and get to fresh air. (4) Should safety valve open, it indicates excessive pressure in regulator. Operate emergency bypass valve (red) and get to fresh air. (5) When hand on regulator pressure gauge drops to warning sector, (300 p.s.i., approximately 4 minutes remaining), start for fresh air.	

COURSE OUTLINE	GUIDES
(6) Close valves firmly with fingers; do not force.	
(7) IMPORTANT - Make sure that the equipment is clean and dry before placing in the case for storage. In drying the equipment, place the regulator flat with the diaphragm cover downward so that water can drain from under the cover. Observe if water has entered the regulator pressure gauge. If so, unscrew the bezel, remove the gauge glass, rinse with fresh water and allow to dry out. After re-assembly, apply gasket shellac or similar compound to the underside of the gauge assembly to keep water out. Gauges are water resistant but may require additional compound after being in use for a period of time.	
(8) Will not protect against poisoning through skin.	
C. Oxygen-generating breathing equipment.	Rescue & Protective Breathing Prac., p. 38, Fig. 11 & 12
1. Often termed "chemox" which is derived from the chemical in the canister which produces oxygen when contacted by the wearer's exhaled breath.	
2. Three models.	
(a) 30 minute.	
(b) 45 minute.	
(c) 60 minute.	

COURSE OUTLINE	GUIDES
3. Parts.	
(a) Facepiece.	
(1) Lens.	
(2) Head harness.	
(3) Rubber mouthpiece.	
(4) Speaking diaphragm.	
(b) Facepiece valve assembly.	
(1) Starter valve (O.B.A. only).	
(2) Inhalation valve.	
(3) Exhalation valve.	
(4) Relief valve.	
(c) Breathing tubes.	
(1) Inhalation.	
(2) Exhalation.	
(d) Breathing bag.	
(1) Reservoir for oxygen.	
(2) Cooling medium for heated air.	
(e) Plunger assembly.	
(f) Canister.	Rescue & Protective Breathing Prac., p. 52, Fig. 13 & 14

COURSE OUTLINE	GUIDES
(1) Contains chemicals that purify exhaled breath by absorbing carbon dioxide. Generates oxygen.	
(2) Life of canister.	
(g) Frame.	
(1) Supports breathing bags.	
(2) Supports canister holder.	
(h) Canister holder.	
(1) Hinged bail.	
(2) Handwheel.	
(i) Mechanical timer.	
(j) Harness.	
4. Procedures for donning the "chemox".	Rescue & Protective Breathing Prac., p. 55-57, Fig. 15
(a) Before donning, unfasten and straighten all harness straps.	
(b) Pick up equipment, one hand on central casting and other on D-ring assembly; slip harness over head.	
(c) Grasp harness strap, bring end of strap beneath armpit and snap into metal D-ring located on top side of the breastplate. Repeat procedure for opposite strap.	

COURSE OUTLINE	GUIDES
(d) Adjust equipment on body by metal slides on harness straps. Position on body should be such that when facepiece is put on, breathing tubes will permit the greatest freedom of movement of the head. (e) Attach waist strap to the small D-rings on each lower side corner of breast-plate and adjust to hold equipment snugly to body. (f) To place canister in equipment, remove metal protective cap by pulling the metal strip straight out and then straight back across the top of the cap. (g) Remove cardboard and metal discs. (h) Swing ball outward to permit canister to enter the canister guard. (i) Insert canister into canister guard with the opening upward and with the "bulged" side away from the wearer. (Insert canister sufficiently to puncture copper foil.) (j) Then swing bail back under canister and turn the handwheel clockwise until it is held firmly in place. (This action seals against entrance of outside air and forms a closed circuit between facepiece and breathing bag.) (k) Don facepiece. (l) Loosen straps, fold them across the top of the facepiece, and grasp mask at upper sides with both hands.	

COURSE OUTLINE	GUIDES

(2) Place chin into pocket at bottom and fit facepiece to forehead and temples.

(3) Remove hands from facepiece, but hold the harness and pull it over the top of the head.

(4) Tighten chin straps first by pulling out and back on tabs. (Bottom strap should be across back of neck and below ears, and harness should be on back of head, not on top.)

(5) Tighten temple straps.

(6) Tighten top straps.

(l) With facepiece in position, grasp both breathing tubes with right hand, squeeze tightly, depress starter valve and inhale, then release starter valve and tubes and exhale into equipment. Repeat this for several complete respirations to inflate breathing bag and start chemical action in canister. Always inflate bag by above procedure before using the equipment since such procedure is absolutely necessary to start action of the chemical. (M.S.A. has introduced the 30-minute self-starter "Chemox" unit.)

(m) After inflating the bag, turn pointer on timer dial clockwise to number 30. As equipment is used, the pointer will return to zero at which point a bell will sound.

COURSE OUTLINE	GUIDES

If there has been no noticeable resistance to breathing, reset pointer on timer for an additional 15 minutes work. When the timer bell sounds after canister has been in use 30 or 45 minutes, or when it becomes an effort to exhale, immediately return to fresh air. (Under extreme exertion, time may be reduced.)

(n) If excessive pressure should develop, open release valve allowing some of the oxygen moisture to escape.

(o) As a precaution, set timer under maximum time to allow adequate time for return to fresh air.

5. Inspection, testing, and care of oxygen-generating breathing equipment.

(a) Periodically inspect main casting and plunger assembly.

(b) Weekly inspection for deterioration or injury to breathing bag, facepiece, breathing tubes, and harness.

(c) Never use oil or grease on the unit.

(d) Always clean after each use. Wash facepiece and breathing tubes in warm, soapy water and disinfectant.

6. Precautions to be observed with oxygen-generating breathing equipment.

(a) Do not allow any liquid, especially oil, grease, or gasoline to enter a used canister.

COURSE OUTLINE	GUIDES

(b) Do not hold face over canister opening.

(c) Partially used canisters cannot be re-used. Destroy any open canister properly.

(d) Puncture the sides of used canisters in accordance with the manufacturer's instructions and dissipate the chemical in a pail of clean water.

(1) Always place in water out of doors.

(2) The chemical is caustic and thus injurious to the skin.

D. Filter type breathing equipment.

1. All filter type breathing equipment has definite limitations which make them dangerous and hazardous to use.

2. Filter masks are not safe to use in atmospheres deficient in oxygen.

3. Many states have passed laws prohibiting their use in the fire service.

4. The National Fire Protection Association no longer recognizes filter type breathing equipment as meeting requirements for protective breathing equipment.

E. Supplied-air-type breathing equipment.

1. This type of equipment is not designed for firefighting, but can be used during certain kinds of rescue. The supplied-air protective breathing equipment is commonly referred to as "hose masks."

COURSE OUTLINE	GUIDES
2. They consist of a facepiece, up to 150 feet of reinforced hose and a hand-operated or electrically operated centrifugal blower. Hose masks are used to furnish fresh air to the workman who must enter and work in highly concentrated gaseous or oxygen deficient atmospheres within a short distance of fresh air in places such as tank cars, oil storage tanks, sewers, etc. Units are available for supplying as many as four men. Fresh air is taken from the outside and blown through the hose attached to the mask facepiece. The wearer is restricted in his travels by the hose. As long as the blower, which must be operated by an attendant, is in uncontaminated air, the wearer is dependent of the atmosphere surrounding him.	
3. One hazard of this type of mask to which the others are not subject is that a beam or other heavy material may drop on the hose, cutting it or shutting off the air. There is no limit on the length of time it can be used.	